TECHNICAL MEMORANDUM

TO: Dennis Crumpler / OAQPS

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DATE: March 10, 2009

SUBJECT: Gravimetric Inter-Laboratory Comparison Study

Introduction

The National Air and Radiation Environmental Laboratory (NAREL) has completed another gravimetric comparison study to evaluate laboratories that weigh Teflon® filters used in $PM_{2.5}$ air monitoring programs. EPA participants of this study included the Region 4 laboratory in Athens, GA; the Region 2 laboratory in Edison, NJ; the Radiation and Indoor Environments Laboratory (R&IE) in Las Vegas, NV; and the Office of Air Quality Planning and Standards (OAQPS) laboratory in Research Triangle Park (RTP), NC. The Region 4 laboratory provides pre- and post-weighing of filters for the $PM_{2.5}$ Performance Evaluation Program (PEP). The R&IE Laboratory provides pre- and post-weighing of Teflon® filters in support of the Tribal Air Monitoring Support (TAMS) $PM_{2.5}$ air monitoring program. Region 2 provides quality assurance oversight of laboratories in the region that weigh filters for the $PM_{2.5}$ program. The OAQPS laboratory performs special studies and serves as a backup weighing facility for the $PM_{2.5}$ PEP. A fifth laboratory included in this study is the Maryland Department of Health and Mental Hygiene (DHMH) Laboratory Division. The DHMH laboratory provides the Maryland Department of the Environment (MDE) analytical services that include weighing of Teflon® filters used to collect $PM_{2.5}$. NAREL coordinated this study by supplying performance evaluation (PE) samples and served as the reference laboratory.

Mass determination of $PM_{2.5}$ typically proceeds by weighing the Teflon® collection filter before and after the sampling event. The amount of particulate matter ($PM_{2.5}$) captured onto the surface of the filter can be calculated by a simple subtraction of the tare or pre-mass from the loaded filter or post-mass. In order to accurately measure particulate mass at microgram levels, the microbalance must be located in a clean, dust free environmental chamber with precise temperature and humidity control. Elimination of static from samples is also very important for accurate mass measurements.

All laboratories participating in this study are equipped with microbalances capable of mass measurements of one microgram sensitivity. NAREL, Region 4, R&IE, OAQPS, and DHMH laboratories perform mass measurements inside environmentally controlled weighing rooms in order to maintain a constant temperature and humidity and to control dust contamination. The Region 2 laboratory utilizes a glove box that has been modified with temperature and humidity controls as well as HEPA filtered air to maintain constant environmental conditions. Samples are conditioned and weighed inside the modified glove box.

Samples for this study were created at NAREL using Met One SASS air samplers to collect various amounts of $PM_{2.5}$ onto Teflon® filters. In addition to the loaded filter samples, blank filters and metallic weights were also included as controls and to provide information concerning balance stability and calibration. This study compares captured mass determined by NAREL to captured mass determined by each of the participating laboratories.

Acceptance criteria for this type of comparison have not been established. There are PEP criteria established for laboratory and field blanks, and metallic standards. Laboratory and field blanks should not vary by more than 0.015 mg and 0.030 mg respectively between pre- and post-measurements. Metallic standards should not vary by more than 0.003 mg. As an alternative to the PEP criteria, this study uses criteria based on actual mass data compiled from gravimetric PE studies administered by NAREL.

Experimental

To begin this study, five sample sets consisting of ten new Teflon® filters and two metallic weights were assembled. Each filter was carefully inspected using a light table to check for pinholes and fibers. The metallic weights were commercially available 100 and 200 milligram stainless steel weights that were slightly altered by clipping a small corner section from each weight. The filters and metallic weights were placed into individual labeled Petri slides. Sample sets were shipped to each laboratory with instructions to equilibrate and tare the samples following their standard operating procedures for the determination of $PM_{2.5}$ mass. The laboratories were asked to complete this part of the study in approximately one week from receipt of the samples. As soon as each sample set was returned to NAREL, it was placed in the weighing chamber and inspected for pinholes and visible contamination. After allowing sufficient time for equilibration, the filters were weighed to determine NAREL's pre-mass. A second weigh session was also performed to verify the pre-mass results. Once NAREL's pre-mass was determined for a returned set of samples, the Petri-slide containers were left closed until all sample sets were returned and tared. After the NAREL pre-masses were established for all samples, seven of the ten filters from each of the sets were loaded with $PM_{2.5}$ collected from the ambient air at NAREL. The remaining three filters from each set were utilized as blanks.

Three co-located Met One Super SASS air samplers located on the NAREL roof were used to load Teflon® filters with $PM_{2.5}$ mass. The co-located samplers have sufficient flow controlled channels available to create ten replicate samples during a sampling event. Four events ranging from 20 to 48 hours in duration were required to load the filters. This allows each laboratory a duplicate pair of filters for three events and a single filter for one event. Sampling events are summarized in Table 13.

Following each collection event, samples were returned to NAREL's weighing chamber for equilibration. When all samples were equilibrated, the post-mass was determined. A post-mass was also determined for the remaining blank filters and metallic weights. The last weigh session before shipping the samples to the sites became NAREL's mass of record.

After the loaded mass was determined at NAREL, each sample set was placed into a cooler with frozen ice packs and a letter of instructions. The coolers were shipped to the participating laboratories by overnight Federal Express.

Instructions provided with the samples allowed laboratories two weeks from the time of receipt to equilibrate and obtain final mass measurements. All samples were then returned to NAREL and given a final inspection.

Note: This study is somewhat atypical of previous gravimetric comparisons conducted by NAREL due a longer than normal timeline for completing the study. The normal time line for the experimental phase of a NAREL gravimetric study is approximately one month. This includes time for shipping, loading of filters, filter equilibration, and mass measurements. This study was significantly longer than normal due to circumstances that prevented some of the participants from completing their tare measurements on schedule. The initial shipment of filters and metallic weights to obtain tare measurements was on November 3, 2008. Some participants were not able to weigh and return their filters until January 2009. Some participants expressed concerns that the inter-lab comparisons could be affected by this longer than normal timeline because good inter-lab agreement depends on samples that are stable in mass. Because of concerns over the stability of the filters, all samples were reweighed as they were returned by the participants in order to determine any mass loss or mass gain of the samples. Table 1 summarizes the results of the reweighed samples compared to the original measurements. The results are based on the average mass obtained by NAREL for each sampling event before shipping (loaded mass 1) and after return from the labs (loaded mass 2). Table 1 also shows the average mass difference where a negative value indicates a loss of mass. Table 1 shows mass loss for the loaded filters and a slight mass gain for the blank filters.

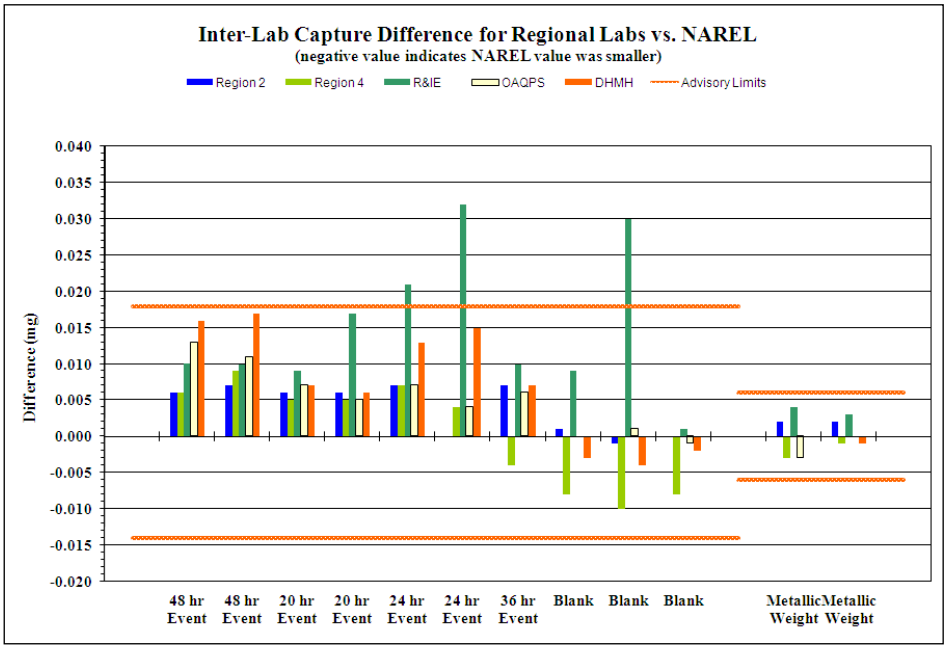
Table 1 NAREL Measurements Before and After Shipping Loaded Filters

Sample Duration (hrs)	Average Loaded Mass 1 (mg)	Average Loaded Mass 2 (mg)	Average Difference (mg)	Number of Samples
48	148.787	148.775	-0.012	10
36	148.753	148.749	-0.003	5
24	148.279	148.272	-0.007	10
20	147.873	147.867	-0.006	10
Blank	147.118	147.122	0.004	15
Metal Wt.	140.511	140.511	0.000	10

Gravimetric Results

Figure 1 presents the inter-laboratory capture differences for all samples. As stated earlier, the capture is calculated by subtracting the pre-mass from the post-mass. NAREL's capture shown in Figure 1 is based on post-masses determined immediately before the samples were shipped to the participants. Inter-laboratory differences were calculated by subtracting the capture value reported by the test laboratory from the capture value determined at NAREL. The advisory limits shown in Figure 1 are 3-sigma limits derived from previous gravimetric PE studies administered by NAREL. The positive bars shown in Figure 1 indicate that NAREL's capture value was larger than the comparison lab's value. The absence of a bar indicates perfect agreement with NAREL. Figure 1 shows that the majority of NAREL's calculated captures were larger than the comparison lab. This positive bias may partially be accounted for by the loss of mass from the loaded filters after NAREL's post-mass measurements were made, as seen in Table 1.

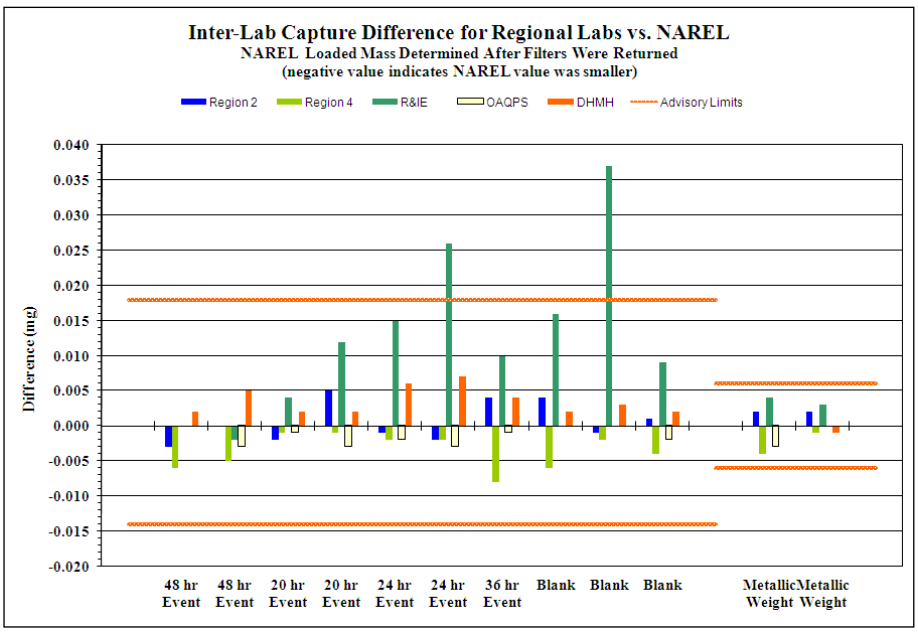
Figure 1



To address concerns over the stability of the samples as indicated in Table 1, NAREL's mass capture was recalculated by subtracting the original tare mass from the loaded mass value obtained after the filters were returned (shown as loaded mass 2 in Table 1). The inter-lab capture differences were re-calculated and the results are shown in Figure 2. In most cases better inter-lab agreement is seen in Figure 2.

Metallic weights were included in this study because they are more stable than a Teflon® filter, especially a loaded Teflon® filter. The metallic weights were weighed at each laboratory during the

Figure 2



initial tare sessions as well as during the final loaded sessions. The difference in initial and final mass is the calculated "mass capture" for the metallic weights. Ideally, the "mass capture" for the metallic weight samples would be zero. A large difference between an initial and final mass could indicate a balance stability or calibration problem.

Figure 2 shows that all inter-lab comparisons for the metallic samples were within the 3 sigma advisory limit. Figure 2 also shows two outliers for the R&IE lab, one of which is a blank filter. Telephone conversations with the R&IE analyst revealed that power outages at the facility had affected the weighing chamber during the time the filters were there. Examination of NAREL's pre-mass data may help to reveal a second possible source for the outliers shown in Figure 2. NAREL routinely weighs all samples before the initial shipment to the participants. As the participants return their pre-weighed samples, NAREL weighs the samples a second time in order to obtain the pre-mass of record that will be subtracted from the post-mass to calculate the mass capture. Ideally, the mass before shipping and the mass on return should agree, indicating that no mass gain or mass loss occurred to the sample while in the possession of the participating lab. Table 2 shows the results of the before and after pre-weighing.

Table 2 Tared filter mass change (mg)

	R&IE	Region 2	Region 4	OAQPS	DHMH
	0.026	0.001	0.005	0.000	0.002
	0.024	0.004	0.003	-0.001	0.001
	0.024	-0.001	0.003	0.001	0.000
	0.025	-0.002	0.003	0.001	0.002
	0.022	0.003	0.002	0.002	-0.001
	0.020	0.002	0.003	0.001	0.000
	0.016	0.001	0.003	0.000	0.001
	0.018	0.000	0.002	-0.001	0.001
	0.020	0.002	0.001	0.001	0.000
	0.018	0.000	-0.001	0.003	0.002
Average	0.021	0.001	0.002	0.001	0.001
Min	0.016	-0.002	-0.001	-0.001	-0.001
Max	0.026	0.004	0.005	0.003	0.002
Stdev	0.003	0.002	0.002	0.001	0.001

Table 2 shows that the unloaded filters sent to R&IE gained as much as 0.026 mg of mass, a significantly larger change than seen for the other labs. The cause of the mass gain is unknown; however, this usually indicates contamination present in the environmental chamber. Further investigation should be conducted by R&IE such as examining data collected for chamber blanks.

The raw data reported from all laboratories have been tabulated in Tables 3 - 12 at the end of this report. NAREL's post-mass measurements shown in Tables 3-7 were determined before the loaded filters were sent to the participating labs. NAREL's post-mass measurements shown in Tables 8-12 were determined after the loaded filters were returned from the labs. The tables

include the results of all filters and the modified metallic standards weighed at each laboratory. The tables contain the filter pre-mass, the final post-mass, and the calculated $PM_{2.5}$ capture for each filter. The tables also contain the calculated inter-laboratory capture differences illustrated in Figures 1 and 2.

Conclusions

This study evaluated laboratories that perform gravimetric measurements of 47 mm Teflon® filter samples used to collect $PM_{2.5}$. Samples for this study were created at NAREL by loading Teflon® filters with $PM_{2.5}$ collected from the ambient air. Blank filters and metallic weights were also included as samples. Each laboratory was allowed to pre-weigh and post-weigh a unique set of samples in order to determine the mass capture for each sample. Performance was evaluated by comparing mass capture results produced by NAREL to results produced by each participating laboratory. This method eliminates slight differences in balance calibration and environmental conditions among different laboratories since both pre- and post-weights are determined at each location using the same balance.

This study began in November, 2008, with the initial shipment of clean Teflon® filters and metallic weights to the participants. The experimental phase of the study was not finished until February, 2009 when all results had been reported and samples returned to NAREL. Because of the longer than normal timeline, there were concerns over the stability of the filter samples. A final weighing performed at NAREL of all samples showed that there was some mass loss of the loaded filters and a slight mass gain of the blank filters. The metallic weights showed no significant change in mass. The inter-lab comparisons shown in Figure 1, which do not allow for the mass changes, show one lab exceeding the advisory limits and another approaching the limits. After allowing for the filters instability, Figure 2 shows improvement for most inter-lab comparisons with only one lab, R&IE, exceeding advisory limits. R&IE results for metallic weights compared relatively well with NAREL values suggesting that balance calibration is not an issue. The positive mass change of the unloaded filters sent to R&IE was significantly larger than from other labs (table 2). Data for R&IE chamber blanks that were with the samples during the study period should be examined to rule out chamber contamination issues.

Table 3. Gravimetric Data Region 2

Sample ID	Pre-Mass Region 2 (mg)	Pre-Mass NAREL (mg)	Post-Mass Region 2 (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 Region 2 (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12590	147.487	147.496	147.643	147.658	0.156	0.162	0.006	48
T08-12591	150.067	150.076	150.224	150.240	0.157	0.164	0.007	48
T08-12592	146.258	146.267	146.296	146.311	0.038	0.044	0.006	20
T08-12593	149.723	149.729	149.758	149.770	0.035	0.041	0.006	20
T08-12594	145.763	145.773	145.833	145.850	0.070	0.077	0.007	24
T08-12595	146.031	146.041	146.105	146.115	0.074	0.074	0.000	24
T08-12596	144.918	144.923	145.033	145.045	0.115	0.122	0.007	36
T08-12597	147.064	147.070	147.062	147.069	-0.002	-0.001	0.001	0
T08-12598	148.016	148.024	148.017	148.024	0.001	0.000	-0.001	0
T08-12599	145.890	145.895	145.889	145.894	-0.001	-0.001	0.000	0
MW08-12632	186.991	186.994	186.989	186.994	-0.002	0.000	0.002	
MW08-12633	90.598	90.601	90.596	90.601	-0.002	0.000	0.002	

* NAREL post-mass value measured before shipping to participant

** Negative values indicate a larger capture determined by participant

Table 4. Gravimetric Data Region 4

Sample ID	Pre-Mass Region 4 (mg)	Pre-Mass NAREL (mg)	Post-Mass Region 4 (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 Region 4 (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12580	146.263	146.263	146.415	146.421	0.152	0.158	0.006	48
T08-12581	147.803	147.801	147.949	147.956	0.146	0.155	0.009	48
T08-12582	146.448	146.445	146.480	146.482	0.032	0.037	0.005	20
T08-12583	145.418	145.415	145.450	145.452	0.032	0.037	0.005	20
T08-12584	147.009	147.005	147.081	147.084	0.072	0.079	0.007	24
T08-12585	148.225	148.222	148.298	148.299	0.073	0.077	0.004	24
T08-12586	148.999	148.999	149.124	149.120	0.125	0.121	-0.004	36
T08-12587	145.875	145.875	145.883	145.875	0.008	0.000	-0.008	0
T08-12588	149.204	149.205	149.214	149.205	0.010	0.000	-0.010	0
T08-12589	145.673	145.671	145.680	145.670	0.007	-0.001	-0.008	0
MW08-12630	181.333	181.335	181.336	181.335	0.003	0.000	-0.003	
MW08-12631	93.773	93.775	93.775	93.776	0.002	0.001	-0.001	

* NAREL post-mass value measured before shipping to participant

** Negative values indicate a larger capture determined by participant

Table 5. Gravimetric Data R&IE

Sample ID	Pre-Mass R&IE (mg)	Pre-Mass NAREL (mg)	Post-Mass R&IE (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 R&IE (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12600	146.299	146.289	146.447	146.447	0.148	0.158	0.010	48
T08-12601	149.823	149.814	149.974	149.975	0.151	0.161	0.010	48
T08-12602	150.841	150.826	150.869	150.863	0.028	0.037	0.009	20
T08-12603	149.509	149.487	149.531	149.526	0.022	0.039	0.017	20
T08-12604	148.714	148.694	148.766	148.767	0.052	0.073	0.021	24
T08-12605	148.352	148.321	148.396	148.397	0.044	0.076	0.032	24
T08-12606	145.926	145.912	146.038	146.034	0.112	0.122	0.010	36
T08-12607	148.626	148.606	148.617	148.606	-0.009	0.000	0.009	0
T08-12608	144.104	144.060	144.073	144.059	-0.031	-0.001	0.030	0
T08-12609	149.934	149.915	149.933	149.915	-0.001	0.000	0.001	0
MW08-12634	188.880	188.880	188.876	188.880	-0.004	0.000	0.004	
MW08-12635	88.207	88.206	88.204	88.206	-0.003	0.000	0.003	

* NAREL post-mass value measured before shipping to participant

** Negative values indicate a larger capture determined by participant

Table 6. Gravimetric Data OAQPS

Sample ID	Pre-Mass OAQPS (mg)	Pre-Mass NAREL (mg)	Post-Mass OAQPS (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 OAQPS (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12610	150.188	150.186	150.334	150.345	0.146	0.159	0.013	48
T08-12611	147.860	147.859	148.011	148.021	0.151	0.162	0.011	48
T08-12613	146.136	146.137	146.169	146.177	0.033	0.040	0.007	20
T08-12617	148.406	148.406	148.438	148.443	0.032	0.037	0.005	20
T08-12614	150.133	150.133	150.199	150.206	0.066	0.073	0.007	24
T08-12615	148.525	148.526	148.594	148.599	0.069	0.073	0.004	24
T08-12616	152.918	152.918	153.032	153.038	0.114	0.120	0.006	36
T08-12618	148.484	148.482	148.483	148.481	-0.001	-0.001	0.000	0
T08-12619	149.528	149.528	149.526	149.527	-0.002	-0.001	0.001	0
T08-12612	149.215	149.216	149.215	149.215	0.000	-0.001	-0.001	0
MW08-12636	190.520	190.522	190.523	190.522	0.003	0.000	-0.003	
MW08-12637	94.830	94.832	94.830	94.832	0.000	0.000	0.000	

* NAREL post-mass value measured before shipping to participant

** Negative values indicate a larger capture determined by participant

Table 7. Gravimetric Data DHMH

Sample ID	Pre-Mass DHMH (mg)	Pre-Mass NAREL (mg)	Post-Mass DHMH (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 DHMH (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12620	148.036	148.036	148.180	148.196	0.144	0.160	0.016	48
T08-12621	152.451	152.450	152.592	152.608	0.141	0.158	0.017	48
T08-12622	149.725	149.725	149.755	149.762	0.030	0.037	0.007	20
T08-12623	145.904	145.905	145.933	145.940	0.029	0.035	0.006	20
T08-12624	150.990	150.989	151.055	151.067	0.065	0.078	0.013	24
T08-12625	148.329	148.327	148.388	148.401	0.059	0.074	0.015	24
T08-12626	150.403	150.402	150.520	150.526	0.117	0.124	0.007	36
T08-12627	148.547	148.547	148.551	148.548	0.004	0.001	-0.003	0
T08-12628	146.672	146.671	146.678	146.673	0.006	0.002	-0.004	0
T08-12629	140.013	140.014	140.017	140.016	0.004	0.002	-0.002	0
MW08-12638	192.422	192.421	192.422	192.421	0.000	0.000	0.000	
MW08-12639	97.545	97.546	97.546	97.546	0.001	0.000	-0.001	

* NAREL post-mass value measured before shipping to participant

** Negative values indicate a larger capture determined by participant

Table 8. Gravimetric Data Region 2

Sample ID	Pre-Mass Region 2 (mg)	Pre-Mass NAREL (mg)	Post-Mass Region 2 (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 Region 2 (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12590	147.487	147.496	147.643	147.649	0.156	0.153	-0.003	48
T08-12591	150.067	150.076	150.224	150.233	0.157	0.157	0.000	48
T08-12592	146.258	146.267	146.296	146.303	0.038	0.036	-0.002	20
T08-12593	149.723	149.729	149.758	149.769	0.035	0.040	0.005	20
T08-12594	145.763	145.773	145.833	145.842	0.070	0.069	-0.001	24
T08-12595	146.031	146.041	146.105	146.113	0.074	0.072	-0.002	24
T08-12596	144.918	144.923	145.033	145.042	0.115	0.119	0.004	36
T08-12597	147.064	147.070	147.062	147.072	-0.002	0.002	0.004	0
T08-12598	148.016	148.024	148.017	148.024	0.001	0.000	-0.001	0
T08-12599	145.890	145.895	145.889	145.895	-0.001	0.000	0.001	0
MW08-12632	186.991	186.994	186.989	186.994	-0.002	0.000	0.002	
MW08-12633	90.598	90.601	90.596	90.601	-0.002	0.000	0.002	

* NAREL post-mass value measured after return from participant

** Negative values indicate a larger capture determined by participant

Table 9. Gravimetric Data Region 4

Sample ID	Pre-Mass Region 4 (mg)	Pre-Mass NAREL (mg)	Post-Mass Region 4 (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 Region 4 (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12580	146.263	146.263	146.415	146.409	0.152	0.146	-0.006	48
T08-12581	147.803	147.801	147.949	147.942	0.146	0.141	-0.005	48
T08-12582	146.448	146.445	146.480	146.476	0.032	0.031	-0.001	20
T08-12583	145.418	145.415	145.450	145.446	0.032	0.031	-0.001	20
T08-12584	147.009	147.005	147.081	147.075	0.072	0.070	-0.002	24
T08-12585	148.225	148.222	148.298	148.293	0.073	0.071	-0.002	24
T08-12586	148.999	148.999	149.124	149.116	0.125	0.117	-0.008	36
T08-12587	145.875	145.875	145.883	145.877	0.008	0.002	-0.006	0
T08-12588	149.204	149.205	149.214	149.213	0.010	0.008	-0.002	0
T08-12589	145.673	145.671	145.680	145.674	0.007	0.003	-0.004	0
MW08-12630	181.333	181.335	181.336	181.334	0.003	-0.001	-0.004	
MW08-12631	93.773	93.775	93.775	93.776	0.002	0.001	-0.001	

* NAREL post-mass value measured after return from participant

** Negative values indicate a larger capture determined by participant

Table 10. Gravimetric Data R&IE

Sample ID	Pre-Mass R&IE (mg)	Pre-Mass NAREL (mg)	Post-Mass R&IE (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 R&IE (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12600	146.299	146.289	146.447	146.437	0.148	0.148	0.000	48
T08-12601	149.823	149.814	149.974	149.963	0.151	0.149	-0.002	48
T08-12602	150.841	150.826	150.869	150.858	0.028	0.032	0.004	20
T08-12603	149.509	149.487	149.531	149.521	0.022	0.034	0.012	20
T08-12604	148.714	148.694	148.766	148.761	0.052	0.067	0.015	24
T08-12605	148.352	148.321	148.396	148.391	0.044	0.070	0.026	24
T08-12606	145.926	145.912	146.038	146.034	0.112	0.122	0.010	36
T08-12607	148.626	148.606	148.617	148.613	-0.009	0.007	0.016	0
T08-12608	144.104	144.060	144.073	144.066	-0.031	0.006	0.037	0
T08-12609	149.934	149.915	149.933	149.923	-0.001	0.008	0.009	0
MW08-12634	188.880	188.880	188.876	188.880	-0.004	0.000	0.004	
MW08-12635	88.207	88.206	88.204	88.206	-0.003	0.000	0.003	

* NAREL post-mass value measured after return from participant

** Negative values indicate a larger capture determined by participant

Table 11. Gravimetric Data OAQPS

Sample ID	Pre-Mass OAQPS (mg)	Pre-Mass NAREL (mg)	Post-Mass OAQPS (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 OAQPS (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12610	150.188	150.186	150.334	150.332	0.146	0.146	0.000	48
T08-12611	147.860	147.859	148.011	148.007	0.151	0.148	-0.003	48
T08-12613	146.136	146.137	146.169	146.169	0.033	0.032	-0.001	20
T08-12617	148.406	148.406	148.438	148.435	0.032	0.029	-0.003	20
T08-12614	150.133	150.133	150.199	150.197	0.066	0.064	-0.002	24
T08-12615	148.525	148.526	148.594	148.592	0.069	0.066	-0.003	24
T08-12616	152.918	152.918	153.032	153.031	0.114	0.113	-0.001	36
T08-12618	148.484	148.482	148.483	148.481	-0.001	-0.001	0.000	Blank
T08-12619	149.528	149.528	149.526	149.526	-0.002	-0.002	0.000	Blank
T08-12612	149.215	149.216	149.215	149.214	0.000	-0.002	-0.002	Blank
MW08-12636	190.520	190.522	190.523	190.522	0.003	0.000	-0.003	
MW08-12637	94.830	94.832	94.830	94.832	0.000	0.000	0.000	

* NAREL post-mass value measured after return from participant

** Negative values indicate a larger capture determined by participant

Table 12. Gravimetric Data DHMH

Sample ID	Pre-Mass DHMH (mg)	Pre-Mass NAREL (mg)	Post-Mass DHMH (mg)	Post-Mass NAREL* (mg)	Captured PM2.5 DHMH (mg)	Captured PM2.5 NAREL (mg)	Inter-Lab Difference** of Captured PM2.5 (mg)	Sampling Duration Hours
T08-12620	148.036	148.036	148.180	148.182	0.144	0.146	0.002	48
T08-12621	152.451	152.450	152.592	152.596	0.141	0.146	0.005	48
T08-12622	149.725	149.725	149.755	149.757	0.030	0.032	0.002	20
T08-12623	145.904	145.905	145.933	145.936	0.029	0.031	0.002	20
T08-12624	150.990	150.989	151.055	151.060	0.065	0.071	0.006	24
T08-12625	148.329	148.327	148.388	148.393	0.059	0.066	0.007	24
T08-12626	150.403	150.402	150.520	150.523	0.117	0.121	0.004	36
T08-12627	148.547	148.547	148.551	148.553	0.004	0.006	0.002	0
T08-12628	146.672	146.671	146.678	146.680	0.006	0.009	0.003	0
T08-12629	140.013	140.014	140.017	140.020	0.004	0.006	0.002	0
MW08-12638	192.422	192.421	192.422	192.421	0.000	0.000	0.000	
MW08-12639	97.545	97.546	97.546	97.546	0.001	0.000	-0.001	

* NAREL post-mass value measured after return from participant

** Negative values indicate a larger capture determined by participant

Table 13. Sampling Schedule

Sample_ID	Filter_ID	Event Start	Event Duration (hr)	Receiving Lab	Filter Condition
T08-12580	T7105151	1/13/2009	48	Region 4	OK
T08-12581	T7105152	1/13/2009	48	Region 4	OK
T08-12582	T7105153	1/15/2009	20	Region 4	OK
T08-12583	T7105154	1/15/2009	20	Region 4	OK
T08-12584	T7105155	1/16/2009	24	Region 4	OK
T08-12585	T7105156	1/16/2009	24	Region 4	OK
T08-12586	T7105157	1/17/2009	36	Region 4	OK
T08-12587	T7105158		Blank	Region 4	OK
T08-12588	T7105159		Blank	Region 4	OK
T08-12589	T7105160		Blank	Region 4	OK
T08-12590	T7105161	1/13/2009	48	Region 2	OK
T08-12591	T7105162	1/13/2009	48	Region 2	OK
T08-12592	T7105163	1/15/2009	20	Region 2	OK
T08-12593	T7105164	1/15/2009	20	Region 2	OK
T08-12594	T7105165	1/16/2009	24	Region 2	OK
T08-12595	T7105166	1/16/2009	24	Region 2	OK
T08-12596	T7105167	1/17/2009	36	Region 2	OK
T08-12597	T7105168		Blank	Region 2	OK
T08-12598	T7105169		Blank	Region 2	OK
T08-12599	T7105170		Blank	Region 2	OK
T08-12600	T7105171	1/13/2009	48	R&IE	OK
T08-12601	T7105172	1/13/2009	48	R&IE	OK
T08-12602	T7105173	1/15/2009	20	R&IE	OK
T08-12603	T7105174	1/15/2009	20	R&IE	OK
T08-12604	T7105175	1/16/2009	24	R&IE	OK
T08-12605	T7105177	1/16/2009	24	R&IE	OK
T08-12606	T7105178	1/17/2009	36	R&IE	OK
T08-12607	T7105179		Blank	R&IE	hole
T08-12608	T7105180		Blank	R&IE	OK
T08-12609	T7105181		Blank	R&IE	OK
T08-12610	T7105182	1/13/2009	48	OAQPS	OK
T08-12611	T7105183	1/13/2009	48	OAQPS	OK
T08-12612	T7105184		Blank	OAQPS	pinhole
T08-12613	T7105185	1/15/2009	20	OAQPS	OK
T08-12614	T7105186	1/16/2009	24	OAQPS	OK
T08-12615	T7105187	1/16/2009	24	OAQPS	OK
T08-12616	T7105188	1/17/2009	36	OAQPS	OK
T08-12617	T7105189	1/15/2009	20	OAQPS	OK
T08-12618	T7105190		Blank	OAQPS	OK
T08-12619	T7105191		Blank	OAQPS	OK

Sample_ID	Filter_ID	Event Start	Event Duration (hr)	Receiving Lab	Filter Condition
T08-12620	T7105192	1/13/2009	48	DHMH	OK
T08-12621	T7105193	1/13/2009	48	DHMH	OK
T08-12622	T7105194	1/15/2009	20	DHMH	OK
T08-12623	T7105195	1/15/2009	20	DHMH	OK
T08-12624	T7105196	1/16/2009	24	DHMH	OK
T08-12625	T7105197	1/16/2009	24	DHMH	OK
T08-12626	T7105198	1/17/2009	36	DHMH	OK
T08-12627	T7105199		Blank	DHMH	OK
T08-12628	T7105200		Blank	DHMH	OK
T08-12629	T7039887		Blank	DHMH	OK